APPENDIX A: ADDITIONAL RESOURCES

GENERAL

American Wind Energy Association (AWEA). Publications include: *Wind Energy Weekly* and *Windletter.* Fax-on-request service: 1-800-634-4299. Web Site: http://www.igc.apc.org/awea. *For a complete publications list, call (202) 383-2500. AWEA is the national trade association of the U.S. wind energy industry.*

Appalachian Mountain Club (AMC). *General Policy on Windpower.* Revised draft approved by AMC Conservation Programs Committee June 1996. Boston, Ma.: AMC, 1996.

Landowner's Guide to Wind Energy in the Upper Midwest. Nancy Lange and William Grant. Minneapolis: Izaak Walton League of America, 1995. *Handbook written for landowners in the Upper Midwest interested in opportunities for wind power development. Discusses how landowners can evaluate their wind resources, how they can evaluate the economics of wind energy under different development scenarios, and the contractual issues between landowner and wind developer.*

Wind Energy Comes of Age. Paul Gipe. New York: John Wiley & Sons, Inc., 1995. *Provides a comprehensive review of the wind energy industry. Addresses development of wind turbine technology, environmental costs and benefits of wind energy, and future development potential of wind energy.*

Wind Energy in America: A History. R. W. Righter. University of Oklahoma Press, 1996.

Wind Energy Resource Atlas of the United States. Elliott, D.L., C.G. Holladay, W.R. Barchet, H.P. Foote, W.F. Sandusky. DOE/CH10093-4. Richland, Washington: Pacific Northwest (Batelle) Laboratory, 1987. http://rredc.nrel.gov/wind/pubs/atlas.

Wind Energy Series. Issue Papers and Briefs released by the National Wind Coordinating Committee. Prepared by M. Brower, J. Chapman, K. Conover, J. Hamrin, R. Putnam. Washington, D.C.: 1997. Available from RESOLVE, Inc., (202) 944-2300 and www.nationalwind.org. *Titles include 1) The Benefits of Wind Energy, 2) Wind Energy Environmental Issues, 3) Siting Issues for Wind Power Plants, 4) Wind Energy Resources, 5) The Effect of Wind Energy Development on State and Local Economies, 6) Utility Procurement of Wind Resources, 7) Wind in a Restructured Electric Industry, 8) Incorporating Wind into Resource Portfolios, 9) Wind Energy Transmission & Utility Integration, 10) Wind Performance Characteristics, and 11) Wind Energy Costs.*

Wind Energy System Operation and Transmission Issues Related to Restructuring. Prepared by Christopher T. Ellison, Andrew B. Brown and Nancy A. Rader for the National Wind Coordinating Committee. Washington, D.C.: NWCC, 1998.

Wind Power for Home & Business: Renewable Energy for the 1990s and Beyond. Paul Gipe. Post Mills, Vermont: Chelsea Green Publishing Co., 1993.

Windy Landowner's Guide to Wind Farm Development. Sam Sadler, et al. Livingston, Montana: Windbooks, 1984.

Windpower Monthly News Magazine. Grand Junction, Colorado.

SITING PROCESS

Energy Aware Planning Guide: Energy Facilities. California Energy Commission: 1996.

Energy Infrastructure of the United States and Projected Siting Needs: Scoping Ideas, Identifying Issues and Options – Draft Report of the Working Group on Energy Facility Siting to the Secretary of the Department of Energy. Department of Energy. December, 1993.

Minnesota State Legislature. Wind Siting Act [Minnesota Statutes, chapter 116C.691-116C.697]. *An act relating to energy; exempting wind energy conversion systems siting from the power plant siting act; authorizing rulemaking; proposing coding for new law in Minnesota Statutes.*

Model State Certification and Siting Code for Electric Transmission Facilities—Final Staff Report of a Keystone Policy Dialogue. The Keystone Center. March, 1994.

Wind/Soar: A Regulatory Guide to Leasing, Permitting, and Licensing in Idaho, Montana, Oregon, and Washington. Don Bain. Portland, Oregon: The Bonneville Power Administration, 1992.

NOISE

See Appendix C for resources related to noise measurement and control.

BIRDS AND OTHER BIOLOGICAL RESOURCES

Effects of Wind Energy Development: An Annotated Bibliography. California Energy Commission (CEC), March 1996.

Avian Monitoring and Risk Assessment at Tehachapi Pass Wind Resource Area, California: 1995 Progress Report. Available from the California Energy Commission, (916) 654-4166.

Proceedings: Avian Interactions with Utility Structures International Workshop. Electric Power Research Institute and Avian Powerline Impact Committee (APLIC), December 1993.

Proceedings of the National Avian-Wind Power Planning Meeting, Denver, Colorado, July 20-21, 1994. Proceedings published April, 1995. DE95004090. Available from NTIS, US Dept. of Commerce, 5285 Port Royal Road, Springfield, VA, 22161. (703) 487-4650. Available on the web at http://www.nrel.gov/wind/avian.html.

Proceedings of the National Avian-Wind Power Planning Meeting II, Palm Springs, California, September 20-22, 1995. Proceedings published October, 1996. NREL/CP-500-23821. Available from NTIS, US Dept. of Commerce, 5285 Port Royal Road, Springfield, VA, 22161. (703) 487-4650. Available on the web at http://www.nrel.gov/wind/avian.html.

VISUAL RESOURCES

Foundations for Visual Project Analysis. Richard C. Smardon, James F. Palmer, and John P. Felleman, eds. New York: John Wiley & Sons, 1986. *Includes chapters on "Landscape Visibility," "Countryside Landscape Visual Assessment," "Simulating Changes in the Landscape," and "Decision-Making Model for Visual Resource Management and Project Review."*

Visual Resource Management Program. US Bureau of Land Management (BLM), 1980. Stock No. 024-011-00116-6. US Government Printing Office, Washington, DC 20402. *The BLM's Visual Resource Management (VRM) procedure assigns numerical ratings to Scenic Quality, Sensitivity Level, and Distance Zones to determine the degree of modification allowable on a given parcel of BLM land. Designed primarily for use in remote, rural areas.*

Wind Turbines in harmony with the landscape. Working report prepared for Logstor Municipality by Moller & Gronborg, architects and planners, AS. *Analysis of wind turbines in a Danish municipality and alternative scenarios for replacing them, with consideration given to visual impacts.*

SOIL EROSION AND WATER QUALITY

Biotechnical Slope Protection and Erosion Control. D.H. Gray and A.T. Lester. New York: Van Nostrand Reinhold, 1992. *Handbook combines engineering and revegetation approaches to erosion control that are accessible to the layperson as well as the professional.*

California Stormwater Best Management Practice Handbook, Construction Activity. Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, and Resources Planning Associates, 1993.

Erosion and Sediment Control Handbook. S.J. Goldman, K. Jackson, T.A. Bursztynsky. New York: McGraw-Hill Inc., 1986.

Erosion Control. *Bimonthly publication of the International Erosion Control Association presents informative articles accessible to the layperson on all aspects of erosion control in the U.S.*

Journal of Soil and Water Conservation. *Bimonthly journal of the Soil and Water Conservation Society. Oriented to agricultural issues, but also contains informative articles on all aspects of erosion control and water quality protection.*

Land and Water. Foster Communications. *Bimonthly magazine with brief, informative articles on recent developments in erosion and runoff control.*

Manual of Standards for Erosion and Sediment Control Measures. Association of Bay Area Governments. Oakland, California: Second edition, 1995.

Reducing the Impacts of Stormwater Runoff from New Development. New York State Department of Environmental Conservation, Division of Water, Bureau of Water Quality Management, 1992. *Handbook reviews stormwater principles and issues for the layperson.*

Revegetation of Disturbed Land in California. L. Van Kekerix and B.L. Kay. California Department of Conservation, Division of Mines and Geology, 1986. *Handbook evaluates the issues involved in the revegetation of disturbed sites. Information applicable to arid portions of the western US.*

Virginia Erosion and Sediment Control Handbook. Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation. Third edition, 1992. *Technical handbook presents planning guidelines and technical design information, including standards and specifications.*

Water Quality, Prevention, Identification and Management of Diffuse Pollution. V. Novotny and H. Olem. New York: Van Nostrand Reinhold, 1994.

CULTURAL AND PALEONTOLOGIC RESOURCES

National Historic Preservation Act of 1966. Includes amendments through 1992. [Title 16, United States Code, section 470]. *This act was adopted by the US Congress to establish a national policy to preserve for public use historic sites, buildings, and objects of national significance for the inspiration and benefit of the people of the United States.*

Executive Order 11593, "Protection of the Cultural Environment," May 13, 1971. [36 Code of Federal Regulations, section 8921 as incorporated into Title 16, United States Code, section 470a]. *This order requires the protection and enhancement of the cultural environment through providing leadership, establishing state offices of historic preservation, and developing criteria for assessing resource values.*

Federal Land Policy and Management Act (FLPMA): 1976. [Title 43 United States Code, sections 1701-1784]. *Requires the Secretary of Interior to retain and maintain public lands in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric water resource, and archaeological values [section 1701(a)(8)]. The Secretary, with respect to the public lands, shall promulgate rules and regulations to carry out the purposes of this Act and of other laws applicable to public lands (section 1740). Based on the directives of this Act, the Department of Interior has developed guidelines for paleontologic resource protection and impact mitigation.*

American Indian Religious Freedom Act, 1978. [title 42 United States Code, section 1996]. *This act protects Native American religious practices, ethnic heritage sites, and land uses.*

Archaeology and Historic Preservation: Secretary of Interior's Standards and Guidelines. [As published in Part IV of the Federal Register on September 29, 1983]. *Developed and published for use by the National Park Service and now used by other federal, state, and some local agencies.*

Regulations of the Advisory Council on Historic Preservation Governing the Section 106 Review Process. Revisions effective October 1, 1986. [36 Code of Federal Regulations, Part 800: Protection of Historic Properties]. *Section 106 of the National Historic Preservation Act of 1966 requires a federal agency head to take into account the effects of an agency's undertakings on properties included in, or eligible for inclusion in, the National Register of Historic Places. These regulations set forth the steps that must be taken to identify, evaluate, and protect eligible or potentially eligible properties.*

Native American Graves Protection and Repatriation Act. 1990. [Title 25, United States Code section 3001, et seq]. *Defines "cultural items," "sacred objects," and "objects of cultural patrimony;" establishes an ownership hierarchy; provides for review; allows excavation of human remains but stipulates return of the remains according to ownership; sets penalties; calls for inventories; and provides for return of specified cultural items.*

Curation of Federally-Owned and Administered Archaeological Collections: Final Rule. [As published in Part III of the Federal Register on September 12, 1990]. *Developed and published for use by the National Park Service and now used by other federal, state, and some local agencies.*

APPENDIX B: SAMPLE LOCAL GOVERNMENT REQUIREMENTS FOR WIND ENERGY CONVERSION SYSTEMS

Examples Taken from Nine California Counties

Additional examples of wind energy permitting laws and guidelines, including those listed in Appendix A, are accessible through NWCC's web site: www.nationalwind.org.

LOCAL GOVERNMENT REQUIREMENTS for WIND ENERGY CONVERSION SYSTEMS (WECS)

REQUIREMENTS	ALAMEDA	CONTRA COSTA	GLENN	KERN	MERCED	MONTEREY	RIVERSIDE	SOLANO	PALM SPRINGS
Setback: Structures (e.g. residences, businesses)	3X total WECS height[1] from residential or commercial zoning[2] (but in no case less than 500 ft)[3] 3X total WECS height from a Dwelling Unit[2] (but in no case less than 500 ft)[4]	A minimum of 1,000 ft from any existing off-site residences or residential areas All WECS, buildings, and structures shall be sited to minimize visual impact to residences within one mile	Horizontal Axis WECS: 2X total WECS height from structures and homes Vertical Axis WECS: At least 10 blade diameters from structures and homes	Minimum 4X total WECS height or 1,000 ft (whichever is greater) from any off-site residence on an adjacent parcel[6] Minimum 1.5X total WECS height from any on-site residence or accessory structure designed for human occupancy	NA	1.25X total WECS height from any habitable structure	*Setback information is for Commercial WECS only* 1.25X to 3X total WECS height from any building[7 8]	Minimum of 10 ft from any structure on the property	No WECS shall be closer than 1,200 ft from any residence, hotel, hospital, school, library, or convalescent home (may be reduced due to factors of topography or the characteristics of the proposed WECS project) 1.25X total WECS height from any off-site building[9]
Setback: Property lines	1.25X total WECS height from all property lines 3X total WECS height from a Building Site upon which a windfarm has not been approved[2] (but in no case less than 300 ft)[4]	3X total WECS height or 500 ft (whichever is greater) from exterior project boundaries	NA	4X total WECS height or 500 ft (whichever is greater) from exterior boundaries if project site is adjacent to parcels of less than 40 acres[6] 1.5X total WECS height from all exterior boundaries if project is adjacent to parcels of 40 acres or more (allowance for setback reduction)	1.25X total WECS height from any exterior property line	2X total WECS height from any property line	1.25X to 3X total WECS height from any lot line[7 8] (If WECS is located in the W-E or W-1 zone) 3X total WECS height from lot line of any lot containing a dwelling[8]	Minimum 1.25X total WECS height from any property line (Setbacks determined by height may be waived when appropriate easements are secured from adjacent property owners) 300 ft from any district which does not permit WECS	1.25X total WECS height from any lot line[9] Minimum 200 ft from any lot line of a lot containing a dwelling
Setback: Public roads, highways	3X total WECS height[2] (but in no case less than 500 ft)[3] 6X total WECS height from the travelled way of I-580[5] (but in no case less than 500 ft)	All WECS, buildings, and structures shall be sited to minimize visual impact to adjacent roadways, and County scenic routes	NA	Minimum 1.5X total WECS height	1.25X total WECS height	5X total WECS height from the right-of-way line of any public road or highway	1.25X to 3X total WECS height[7 8] Scenic setbacks required from various state highways	NA	1.25X total WECS height[9] Scenic setbacks required from various state highways and roads
Setback: Railroads	NA	NA	NA	Minimum 1.5X total WECS height	NA	NA	1.25X to 3X total WECS height[7 8]	NA	1.25X total WECS height[9]
Setback: Above Ground Transmission Lines (more than 12 kv)	NA	NA	NA	NA	NA	NA	1.25X total WECS height	NA	1.25X total WECS height

LOCAL GOVERNMENT REQUIREMENTS for WIND ENERGY CONVERSION SYSTEMS (WECS) (cont)

REQUIREMENTS	ALAMEDA	CONTRA COSTA	GLENN	KERN	MERCED	MONTEREY	RIVERSIDE	SOLANO	PALM SPRINGS
Noise Levels	Not closer than 1,000 ft in an upwind direction from any dwelling; nor closer than 300 ft in any other direction from any dwelling or Building Site; bonds required[10]	Not to exceed 65 dB(A) as measured at any lot line Cash deposit of $3,000 used in the investigation and evaluation of a noise complaint or permit violation	*Noncommercial WECS:* Not to exceed 65 dB, measured at nearest residential dwelling *Commercial WECS:* Not to exceed 65 dB, measured at nearest inhabited structure	Not to exceed 45 dB(A) for more than 5 minutes out of any hour; or to exceed 50 dB(A) for any period measured within 50 ft of home, school, hospital, church, or public library	Not to exceed 60 dB(A) CNEL from closest existing residence	In compliance with Noise Element of the General Plan	Not to exceed 65 dB(A); 60 dB(A) if point of measurement is adjacent to a lot used for residential, hospital, school, library, or nursing home purposes; Accessory WECS not to exceed 60 dB(A)	Not to exceed 50 dB(A) CNEL at any property line abutting a residential zone; 60 dB(A) CNEL at any other property line	Not to exceed 55 dB(A) at measurement point; limit reduced by 5 dB(A) if pure tone noise will be generated; setbacks[12]
Interference with Broadcast Signals/ Navigational Systems	NA	Shall be designed, installed, and operated so that no distrupting electromagnetic interference is caused	Shall not create electromagnetic interference that can disrupt local residents or businesses	NA	Wind turbines shall be filtered and/or shielded to prevent interference with broadcasting signals	No disrupting electromagnetic interference shall be caused	Shall comply with FAA regulations for siting structures near an airport or VORTAC station	Wind turbines shall be filtered and/or shielded to prevent interference with broadcasting signals	Shall comply with FAA regulations for siting structures near an airport or VORTAC station
Avian Injury/ Mortality	File reports; obtain veterinary care; pay monitoring fees[11]	NA	File reports; contact avian rehabilitation center	NA	NA	NA	Report all dead birds found within 500 ft of a WECS	File reports; annual fee to fund avian activity research (Limited term, now expired)	Report all dead birds found within 500 ft of a WECS
Distribution Lines/ Power Poles	Electrocution protection measures	NA	NA	All on-site electrical wires associated with WECS shall be installed underground	NA	NA	Electrical distribution lines on project site shall be undergrounded	Transmission lines under-grounded; raptor protection measures	Electrical distribution lines on project site shall be undergrounded; raptor protection
Soil Erosion/ Sedimentation Control Plan	Required prior to issuance of any building permits	NA	NA	Required prior to issuance of any building permits; surety bond to guarantee implementation	Erosion control plan required	NA	NA	Grading/erosion/ sedimentation control plan required	NA
Inoperable or Unsafe WECS/Site Reclamation	Has not produced electricity in 1year;50% of turb-ines being remov-ed or in disrepair, permittee shall restore site; cash performance deposit required	Reclamation plan required; cash deposit required to insure completion of site reclamation	Not operational or not producing electricity, dismantle blades within 6 months; not operational for continous 2 year period, reclaim site to natural state	NA	Reclamation plan and bond required	Not operational for continous period of 1 year, required to be removed; permittee shall maintain a fund payable to County for the removal	Inoperable and unsafe WECS shall be repaired or removed by the owner; site shall be restored to its natural condition; a bond may be required	Surety bonds may be required to guanantee removal of any abandoned windmills	Not operational for continous 1 year period WECS shall be declared a public nuisance and must be repaired or removed; a bond may be required
Encountering Achaeological Resources	Halt work within 30 meter radius; retain archaeologist	NA	NA	NA	NA	NA	NA	Halt work; retain archaeologist	NA

LOCAL GOVERNMENT REQUIREMENTS for WIND ENERGY CONVERSION SYSTEMS (WECS) (cont)

REQUIREMENTS	ALAMEDA	CONTRA COSTA	GLENN	KERN	MERCED	MONTEREY	RIVERSIDE	SOLANO	PALM SPRINGS
Safety/Security	Maintain phone numbers of inhabitants of all adjacent properties in event of fire	Warning signs; manual and automatic controls to limit blade speed; tower access limitation	NA	Warning signs; fencing; fuel break	Braking system; blade pitch control; manual and auto overspeed controls	Fencing; warning signs; manual and auto controls to limit blade speed	Fencing; guy wires marked; warning signs; fire protection measures	Windmill equipped with braking system; blade pitch control	Fencing; warning signs; fire protection
WECS Height	NA	NA	NA	Not to exceed maximum height allowed for antennae and towers by the district with which Wind Energy District is combined	NA	*Noncommercial WECS:* Not to exceed 50 ft; 100 ft if parcel WECS is located on is 10 acres or larger *Commercial WECS:* 200 ft maximum	*Commercial WECS:* Comply with height limits of zone where located *Accessory WECS:* 80 ft or less in any zone	NA	Not to exceed 200 ft
Height of Blade Tip from Ground	NA	NA	NA	NA	No lower than 15 ft unless enclosed by 6 ft high fence	Lowest position of blade shall be at least 30 ft above the ground and 30 ft above highest existing structure or tree within a 250 ft radius	*Horizontal axis WECS:* No lower than 25 ft; *Vertical axis WECS:* If rotors are <15 ft from the ground, WECS shall be enclosed by a fence	Minimum 15 ft from ground unless enclosed by 6 ft high fence	*Horizontal axis WECS:* No lower than 25 ft; *Vertical axis WECS:* If rotors are <15 ft from the ground, WECS shall be enclosed by a fence
Density	NA	NA	1 turbine per 10 acres	Accordance with industry standards	NA	NA	NA	NA	NA
Color/Finish	Blend with surroundings	Nonreflective, unobtrusive color	NA	Nonreflective, unobtrusive color; nonreflective surface	Nonreflective, nongloss gray	Colors and surface treatment shall minimize disruption	Light environmental colors, or darker, fully-saturated colors; matte or galvanized finish	Neutral, nonreflective	Light environmental colors, or darker, fully-saturated colors; matte or galvanized finish
Project Identification Signs/Advertising/ Logos	NA	No advertising sign or logo on any WECS; no more than 2 project identification signs, not to exceed 16 sq ft in area or 8 ft in height	NA	One project identification sign, not to exceed 32 sq ft in area	Brand names or advertising shall not be visible from any public access	NA	No advertising sign or logos on WECS; no more than 2 signs relating to the development allowed, not to exceed 15 sq ft in area or 8 ft in height	Brand names or advertising shall not be visible from any public access	One project idenification sign, not to exceed 50 sq ft or 8 ft in height; no advertising signs or logos on WECS
Status Report	Rated capacity, meteorological data, actual power generated	NA	NA	NA	NA	NA	Quarterly power production report to the Planning Department	Rated capacity, meteorological data, actual power generated	NA
Insurance Policy	Comprehensive General Liability in minimum of $1,000,000	NA	NA	NA	NA	Shall maintain an insurance policy to cover installation and operation of WECS	NA	General Liability and Workers' Compensation in minimum of $1,000,000	NA

APPENDIX B NOTES

[1] Total WECS height is measured from grade to the uppermost extension of any blade, or the maximum height reached by any part of the windmill.

[2] If the ground elevation of the windmill is 2 or more times the height of the windmill above the protected feature, the setback shall be 4X total height of the windmill.

[3] A reduction may be granted if it is shown in a report prepared by a qualified professional, and verified by the County, that a lesser minimum setback is adequate, however, in no case shall a setback less than 300 ft ever be provided.

[4] This setback may be reduced by a maximum of 50% if the written, notarized, and recorded agreement of the affected property owner is obtained.

[5] Setback from the travelled way of I-580 shall be 8X the total height of the windmill if the ground elevation of the windmill is 2 or more times the height of the windmill above the travelled way of I-580.

[6] The Planning Director may allow a reduction in this setback, not to exceed a minimum setback of 1.5X total WECS height, if a letter of consent from the owner of the adjacent parcel is filed with the Planning Department.

[7] If WECS is located in the W-E zone or W-1 zone, the setback shall be 1.25X the total WECS height from the protected feature. If located in any other zone, the setback shall be 3X the total WECS height.

[8] This setback shall be reduced to 1.25X total WECS height if WECS is certified as complying with safety standards or may be reduced to 1.25X total WECS height if the topography of the adjacent property eliminates or substantially reduces potential safety hazards.

[9] This setback may be reduced to less than 1.25X total WECS height if Planning Commission determines that the topography of, or other conditions related to, the adjacent property or right-of-way eliminates or substantially reduces the potential safety hazards.

[10] A cash bond in the amount of $2,000 to be used in the investigation of a noise complaint. A $10,000 performance bond which shall inure to the benefit of property owners or residents within one half mile of the windfarm who suffer damage as a result of a violation of the noise standard.

[11] Fees shall be used by County to hire a consultant to prepare a permanent compliance monitoring program to oversee compliance with existing and proposed mitigation measures, EIR, and General Plan.

[12] Wind turbines prohibited within 200 ft of any property used for residential, hotel, hospital, school, library or convalescent home purposes. Acoustical report indicating compliance with noise level limits required for wind turbine development at a distance between 200 ft and 3,000 ft from previously stated land uses. At distances greater than 3,000 ft from previously stated land uses, development may be permitted without acoustical study.

[13] WECS shall be equipped with air traffic warning lights and shall have prominent orange markings on the rotor blade tips if total height exceeds 175 ft or if any WECS exceeding 125 ft in total height is placed at an elevation over 200 ft.

APPENDIX C: NOISE MEASUREMENT

INTRODUCTION

Sound is typically measured in decibels (dB). The decibel scale is logarithmic and results in the following relationships:

- except under laboratory conditions, a change in sound level of 1 dB cannot be perceived;
- outside of the laboratory, a 3 dB change in sound level is considered a barely discernable difference;
- a change in sound level of 5 dB will typically result in a noticeable community response; and
- a 10 dB increase is subjectively heard as an approximate doubling in loudness, and almost always causes an adverse community response.

In determining responses to changes in noise, analysts usually measure noise in decibels on a weighted scale or dB. This scale is similar to the response of the human ear. Other statistical descriptors are used to describe the time-varying character of ambient noise, and to account for greater sensitivity to nighttime noise levels. (See Table C-1.)

In a typical community or habitation, ambient (background) noise is typically a conglomeration of noise from nearby and distant sources, relatively steady and homogeneous, with no particular source identifiable within it. Manmade noise is noticeable to many receptors when it exceeds the naturally occurring background noise by about 3 dB. Tonal (distinct frequency) noise is much more noticeable at the same relative loudness level because it is composed of one or more distinct tones, which stand out against broadband (multi-frequency) background noise.

WIND TURBINE ACOUSTICS STANDARDS

A number of noise measurement techniques have been developed that are specific to wind energy systems:

- "A Proposed Metric for assessing the Potential of Community Annoyance for Wind Turbine Low Frequency Noise Emissions" (SERI/TP-217-3261). Published in November, 1987 by the Solar Energy Research Institute (now the National Renewable Energy Laboratory) based in Golden, Colorado. In this publication, Neil Kelly proposed a low frequency noise metric.
- "Procedure for Measurement of Acoustic Emissions from Wind Turbine Generator Systems, Tier 1 - 2.1" Published by the American Wind Energy Association (AWEA), Washington, DC, 1989. Copies of AWEA's measurement procedure are available from AWEA's Publications Department at (202) 383-2520.

In addition to these, a standard measurement document is being developed by the International Electrotechnical Commission (IEC)'s Technical Committee 88 (TC-88) on Wind Turbine Generator Systems. The document was prepared by Working Group 5 on Acoustic Measurement Techniques for Wind Turbine Noise Emissions. It was balloted as a Draft International Standard, but the draft was rejected. The draft may either be revised and balloted again, or a new acoustics standard may be developed based on recent scientific advances. To obtain the most current information about the status of this standard, contact the IEC at:

- International Electrotechnical Commission
  3, rue de Varembe
  P.O. Box 131
  1211 Geneva 20
  Switzerland
  Phone: 011-41-22-919-0211
  Fax: 011-41-22-919-0300

ADDITIONAL NOISE MEASUREMENT REFERENCES/RESOURCES

California Department of Health Services, Office of Noise Control. *Guidelines for Preparation and Content of Noise Elements in General Plans,* 1976.

California Department of Health Services, Office of Noise Control. *Model Community Noise Control Ordinances,* 1977.

Charles M. Salter Associates, Inc. *Guidelines for Preparing Environmental Impact Statements on Noise.* National Research Council / National Academy of Sciences, 1977.

Peterson, Arnold P. G. and Ervin E. Gross, Jr. Handbook of Noise Measurement, 7th ed. GenRad, Concord, Mass., 1974.

Suter, Alice H., "Noise Sources and Effects - A New Look." Sound and Vibration, January 1992.

Thumann, Albert and Richard K. Miller, Fundamentals of Noise Control Engineering. Prentice-Hall, 1986.

U.S. Environmental Protection Agency (EPA). Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (55/9-74-004), 1974.

Typical Environmental and Industry Sound Levels

Source/Distance from Source	A-Weighted Sound Level	Environmental Noise	Subjectivity/ Impression
Civil Defense Siren [Tonal]	140-130		Pain Threshold
Jet Takeoff (200') [Broadband and Tonal]	120		
	110	Rock Music Concert	Very Loud
Pile Drive (50') [Impulsive]	100		
Ambulance Siren (100') [Tonal]	90	Boiler Room	
Freight Cars (50') [Broadband and Impulsive]	80		
Pneumatic Drill (50') [Broadband]	80	Printing Press Kitchen Garbage Disposal	Loud
Freeway (100') [Broadband]	70		Moderately Loud
Vacuum Cleaner (100') [Broadband and Tonal]	60	Data Processing Center Department Store/Office	
Light Traffic (100') [Broadband]	50	Private Business Office	Quiet
Large Transformer (200') [Tonal]	40		
Soft Whisper (5')	30	Quiet Bedroom	
	20	Recording Studio	
	0-10		Threshold of Hearing

Source: Peterson and Gross, 1974

Definition of Some Technical Terms Related to Noise

Decibel, dB	*A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).*
Frequency, Hz	*The number of complete pressure fluctuations per second above and below atmospheric pressure.*
A-Weighted Sound Level, dB	*The sound pressure level in decibels as measured on a Sound Level Meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this paper are A-weighted.*
L_{10}, L_{50}, & L_{90}	*The A-weighted noise levels that are exceeded 10%, 50%, and 90% of the time, respectively, during the measurement period. L_{90} is generally taken as the background noise level.*
Equivalent Noise Level L_{eq}	*The average A-weighted noise level during the Noise Level measurement period.*
Community Noise Equivalent Level, CNEL	*The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels to levels in the evening from 7 p.m. to 10 p.m. and after addition of 10 decibels to sound levels in the night between 10 pm and 7 am.*
Day-Night Level, L_{dn}	*The Average A-Weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10 p.m. and 7 a.m.*
Ambient Noise Level	*The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.*
Intrusive Noise	*That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.*

Source: California Department of Health Services, 1976.

APPENDIX D: LIST OF INTERVIEWEES

The National Wind Coordinating Committee gratefully acknowledges the input of the following individuals, who agreed to share their experience and expertise in the permitting of wind energy facilities in confidential interviews with the authors of this handbook.

John Balestrery
Merced County, California

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NWCC members and alternates include representatives from:

American Wind Energy Association

California Energy Commission

Colorado Public Utilities Commission

Conservation Law Foundation

Edison Electric Institute

Electric Power Research Institute

Enron Wind Corporation/Zond Systems

Environmental & Energy Study Institute

Environmental Defense Fund

Green Mountain Power Corporation

Iowa Department of Natural Resources

Izaak Walton League of America

Minnesota Attorney General's Office

Minnesota Public Utilities Commission

Missouri Public Counsel's Office

Montana Power Company

National Association of Regulatory Utility Commissioners

National Association of State Energy Offices

National Conference of State Legislatures

New Hampshire Consumer Advocate Office

Northern States Power

Ohio Consumer Counsel

Oregon Public Utility Commission

PacifiCorp

ReGen Technologies/AllEnergy

Texas General Land Office

Texas State Energy Conservation Office

Union of Concerned Scientists

U.S. Department of Energy

Utility Wind Interest Group

Vermont Department of Public Service

Vermont Public Service Board

Worldwatch Institute

Wyoming Energy and Conservation Office

Wyoming Public Service Commission

The NWCC is a collaborative endeavor formed in 1994 that includes representatives from electric utilities and their support organizations, state legislatures, state utility commissions, consumer advocacy offices, wind equipment suppliers and developers, power marketers, environmental organizations, and state and federal agencies. The National Wind Coordinating Committee identifies issues that affect the use of wind power, establishes dialogue among key stakeholders, and catalyzes appropriate activities to support the development of an environmentally, economically, and politically sustainable market for wind power.

For additional information or to schedule a wind permitting workshop, please contact

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This complete document is available on NWCC's website: http://www.nationalwind.org.